



US008519845B2

(12) **United States Patent**  
**Mohandes**

(10) **Patent No.:** **US 8,519,845 B2**  
(45) **Date of Patent:** **\*Aug. 27, 2013**

(54) **SYSTEM AND METHOD FOR TRACKING PEOPLE**

(75) Inventor: **Mohamed Mohandes**, Dhahran (SA)

(73) Assignee: **King Fahd University of Petroleum and Minerals**, Dhahran (SA)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/154,341**

(22) Filed: **Jun. 6, 2011**

(65) **Prior Publication Data**

US 2012/0154148 A1 Jun. 21, 2012

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 12/970,714, filed on Dec. 16, 2010.

(51) **Int. Cl.**  
**G08B 1/08** (2006.01)

(52) **U.S. Cl.**  
USPC ..... **340/539.13; 342/73; 342/357.71; 701/468**

(58) **Field of Classification Search**  
USPC ..... 340/539.1, 539.11, 539.13, 539.22, 340/540; 701/468, 469; 342/73, 357.39, 342/357.63, 357.71

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,100,806 A 8/2000 Gaukel  
6,243,039 B1\* 6/2001 Elliot ..... 342/457  
6,362,778 B2 3/2002 Neher

6,674,368 B2 1/2004 Hawkins et al.  
7,015,817 B2 3/2006 Copley et al.  
7,143,130 B2 11/2006 Lin  
7,181,228 B2 2/2007 Boesch  
7,660,872 B2 2/2010 Delia et al.  
2005/0212701 A1\* 9/2005 Nimmo ..... 342/357.07

(Continued)

**FOREIGN PATENT DOCUMENTS**

WO WO2010114210 A1 10/2010

**OTHER PUBLICATIONS**

Mohamed Mohandes, "A Case Study of an RFID-based System for Pilgrims Identification and Tracking", *Sustainable Radio Frequency Identification Solutions*, Edited by Cristina Turcu, InTech, Feb. 2010, pp. 87-104.

Mohandes, M., "An RFID-based pilgrim identification system (a pilot study)", *Optimization of Electrical and Electronic Equipment, 2008. OPTIM 2008. 11th International Conference on*, May 22-24, 2008, pp. 107-112.

*Primary Examiner* — George Bugg

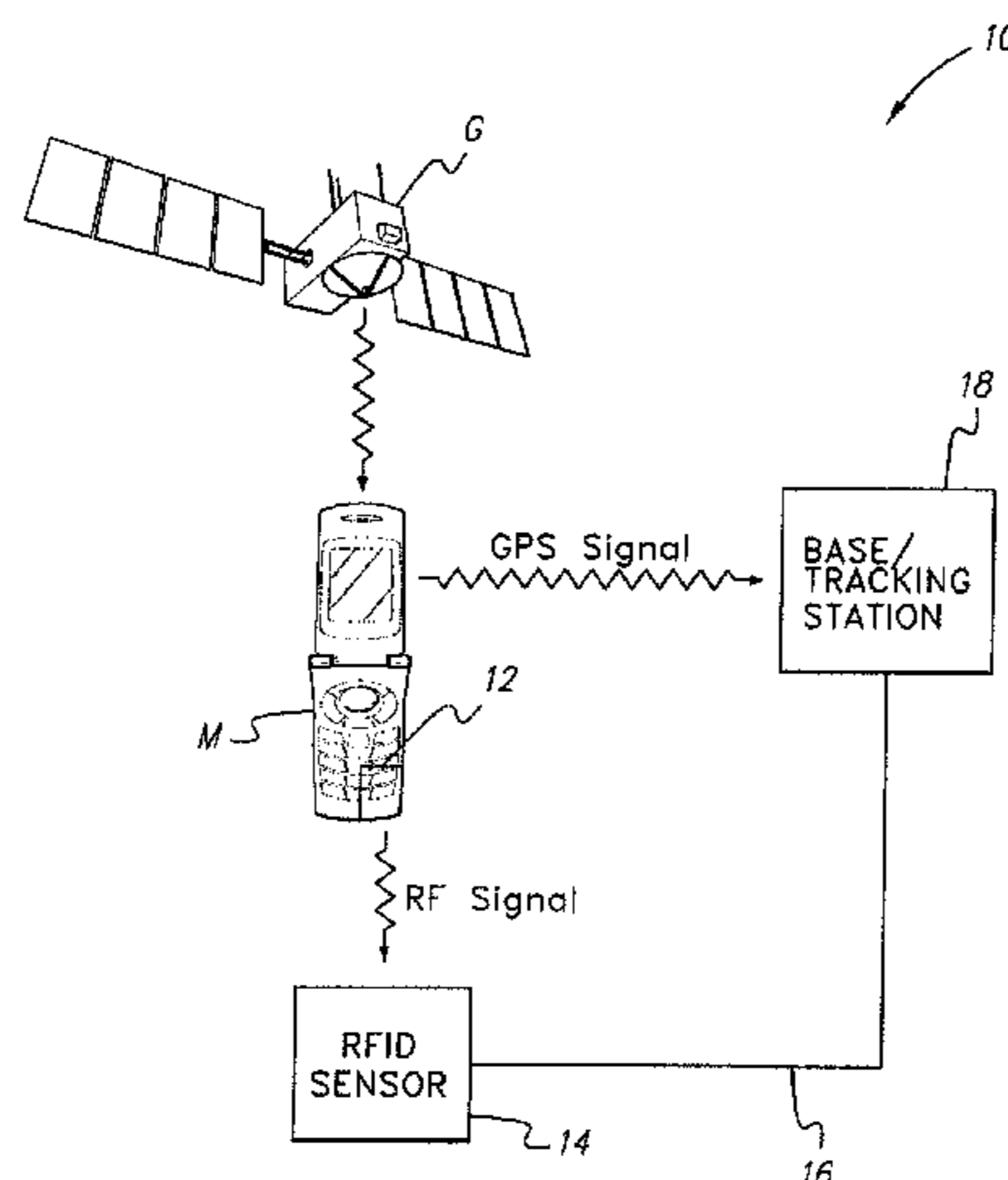
*Assistant Examiner* — Edny Labbees

(74) *Attorney, Agent, or Firm* — Richard C. Litman

(57) **ABSTRACT**

The system and method for tracking people provides for the tracking of individuals in large crowds, such as the tracking of individual pilgrims during the Hajj pilgrimage in Mecca. A polling request is initially transmitted from a tracking station to a mobile device associated with a particular person of interest. Upon receipt of the polling request, a location signal is transmitted back to the tracking station. The location signal includes positional and time data representative of the location of the mobile device at the time of transmission. Additionally, a supplemental location signal is also transmitted to the tracking station, the supplemental location signal being representative of the location of the mobile device when the mobile device is detected within proximity of a fixed sensor. A visual display image of the path of the person of interest is then displayed at the tracking station overlaid on a geographic map.

**20 Claims, 4 Drawing Sheets**



(56)

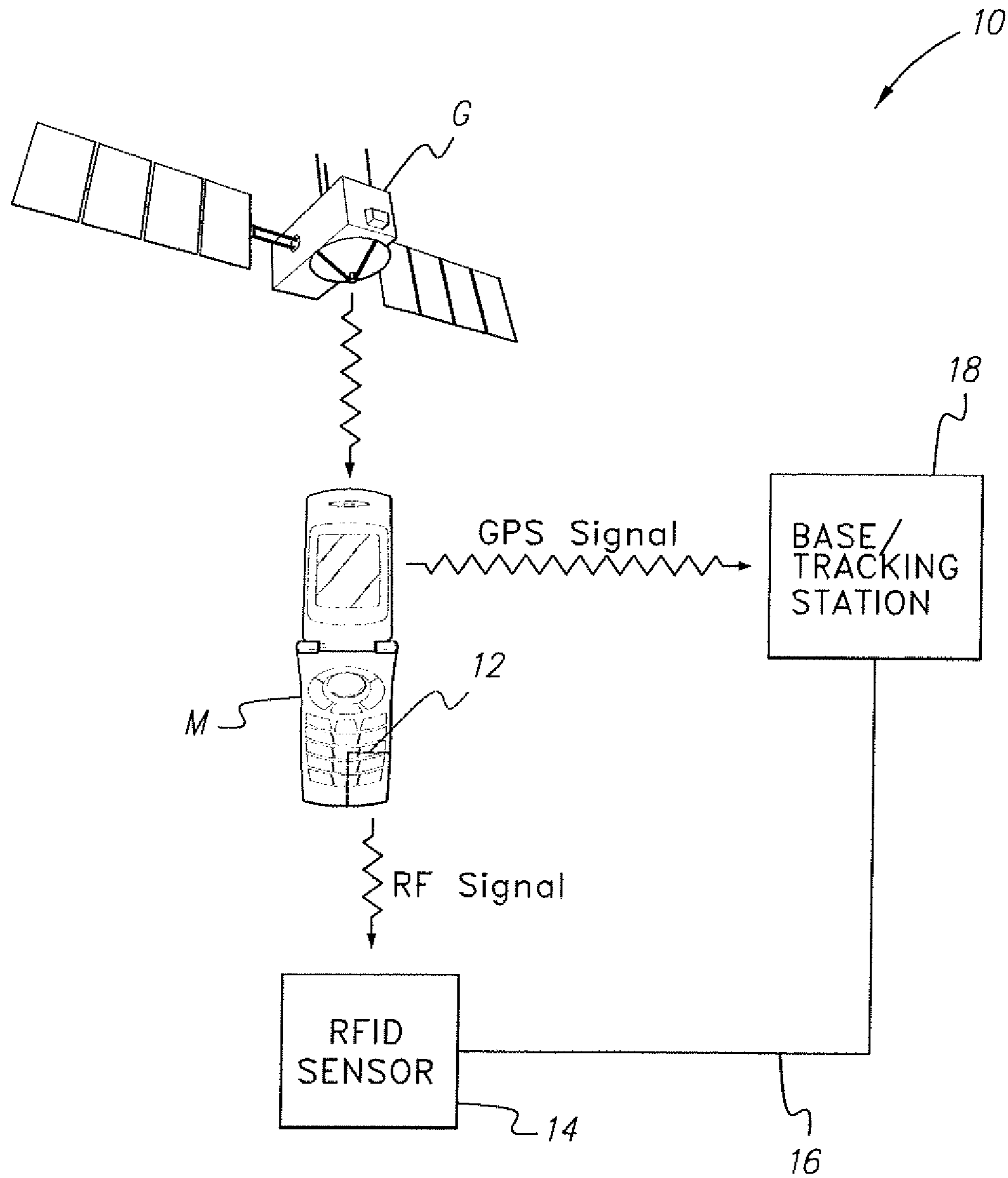
**References Cited**

U.S. PATENT DOCUMENTS

2007/0013526 A1\* 1/2007 Kazdin et al. .... 340/573.4  
2007/0057841 A1 3/2007 McBurney et al.  
2010/0022255 A1\* 1/2010 Singhal ..... 455/457

2010/0078475 A1 4/2010 Lin et al.  
2010/0211507 A1 8/2010 Aabye et al.  
2011/0080262 A1\* 4/2011 Richardson et al. .... 340/8.1  
2011/0234399 A1\* 9/2011 Yan ..... 340/539.32

\* cited by examiner



**FIG. 1**

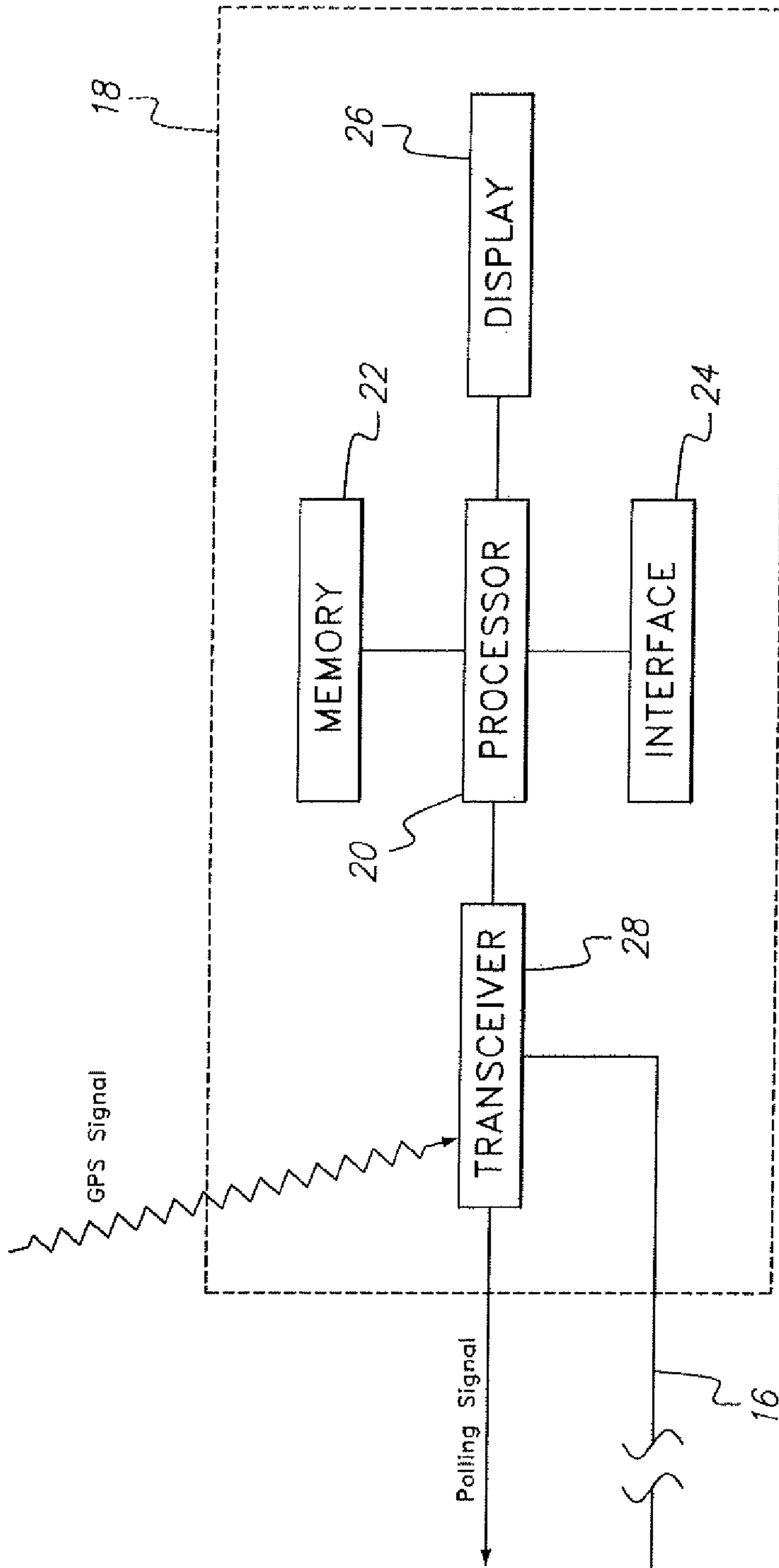


FIG. 2

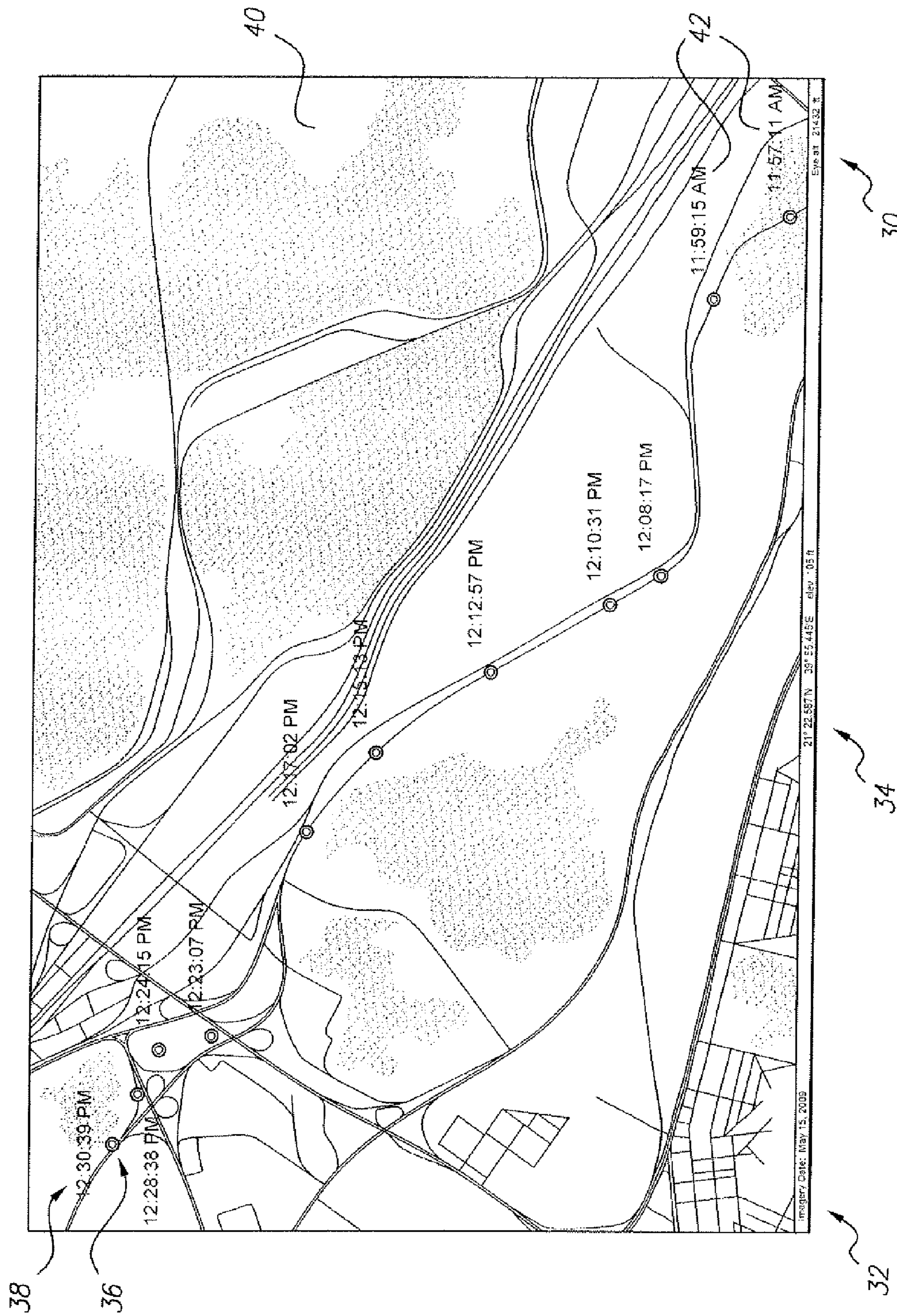
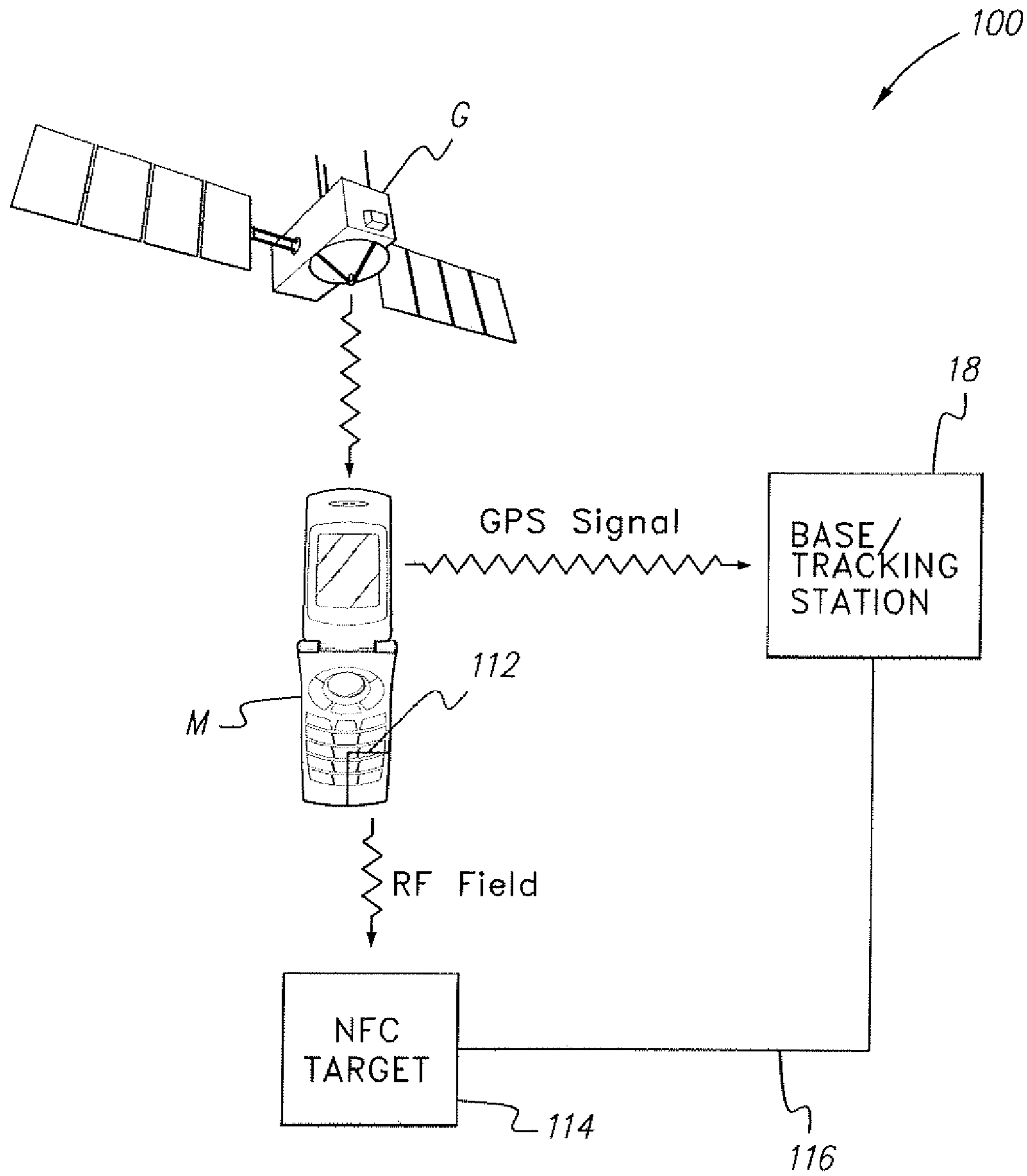


FIG. 3



**FIG. 4**

1

## SYSTEM AND METHOD FOR TRACKING PEOPLE

### CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. patent application Ser. No. 12/970,714, filed Dec. 16, 2010.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to monitoring and tracking, and particularly to a system and method for tracking people in large crowds, such as during the Hajj pilgrimage.

#### 2. Description of the Related Art

The Hajj is a pilgrimage to Mecca to be performed at least once in a Muslim's lifetime. The Hajj is performed within a six-day period each year within designated boundaries inside the city of Mecca. Over 2.5 million pilgrims visit Mecca each year, the pilgrims all congregating within a relatively small region. An additional 4 million visitors come to Mecca at other times of the year. During this time, a number of visitors to Mecca are, instead, attempting to obtain employment and stay in Saudi Arabia illegally. Due to the overwhelming crowd visiting Mecca during this time, it is nearly impossible to regulate all of the visitors to prevent acts of illegal immigration.

It would be of great benefit to authorities to be able to track visitors during the Hajj. Although visual tracking, the use of checkpoints, increased numbers of police officers and officials, and other conventional crowd control methods are presently used, the sheer number of visitors to Mecca within such a small region makes such supervision relatively ineffective. Thus, a system and method for tracking people solving the aforementioned problems is desired.

### SUMMARY OF THE INVENTION

The system and method for tracking people provides for the tracking of individuals in large crowds, such as the tracking of individual pilgrims during the Hajj pilgrimage in Mecca. A polling request is initially transmitted from a base or tracking station to a mobile device, such as a cellular telephone, personal digital assistant or the like, associated with a particular person of interest. Preferably, the polling request includes identification data associated with the mobile device of the person of interest. Upon receipt of the polling request, a location signal is transmitted from the mobile device back to the base or tracking station. The location signal includes positional data and time data representative of the location of the mobile device at the time of transmission of the location signal. Preferably, the mobile device is equipped with a global positioning system (GPS) receiver, allowing the mobile device to receive signals from the global positioning system and calculate the geographic position of the mobile device.

Additionally, a supplemental location signal is also transmitted to the base or tracking station. The supplemental location signal includes supplemental positional data and supplemental time data representative of the location of the mobile device when the mobile device is detected within proximity of a fixed sensor. Preferably, the mobile device has a radio frequency identification (RFID) chip embedded therein, and the fixed sensor is a radio frequency sensor. The RFID chip is encoded with the identification data of the mobile device's user, allowing the position of the nearest radio frequency

2

sensor to be recorded as the approximate position of the person of interest. The positional data and time data, along with the supplemental positional data and the supplemental time data, are recorded in a database as a set of geographic positions and corresponding times associated with a path of the person of interest. A visual display image of the path of the person of interest is then displayed at the base or tracking station, the path being overlaid on a geographic map.

Preferably, an icon representing the person of interest at each recorded position thereof on the path of the person of interest is displayed on the geographic map. Preferably, each icon is initially displayed in a first color. If a location signal is not received at the base or tracking station following transmission of the polling request, and if an updated supplemental location signal is also not received, then the icon associated with the person of interest's last known position is displayed in a second color distinct from the first color. For example, if the person of interest goes inside a building with no cellular service, or has traveled outside of the general geographic area of interest, then the icon representing the last known position would be displayed in a different color on the display at the base or tracking station.

These and other features of the present invention will become readily apparent upon further review of the following specification and drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram of a system for tracking people according to the present invention.

FIG. 2 is a block diagram of base tracking station components in a system for tracking people according to the present invention.

FIG. 3 is an exemplary map display generated by the system for tracking people according to the present invention.

FIG. 4 is a diagram of an alternative embodiment of a system for tracking people according to the present invention. Similar reference characters denote corresponding features consistently throughout the attached drawings.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The system and method for tracking people provides for the tracking of individuals in large crowds, such as the tracking of individual pilgrims during the Hajj pilgrimage in Mecca. A polling request is initially transmitted from a base or tracking station **18** to a mobile device M, such as a cellular telephone, personal digital assistant or the like, associated with a particular person of interest. In FIG. 1, the mobile device M is shown as an exemplary cellular telephone, although it should be understood that system **10** may be used in combination with any desired mobile device capable of receiving and transmitting signals.

Preferably, the polling request includes identification data associated with the mobile device M of the person of interest. The polling request may be transmitted manually, at any desired time, or may be transmitted automatically at predetermined time intervals, such as once every five minutes or once every hour. Upon receipt of the polling request, a location signal is transmitted from the mobile device M back to the base or tracking station **18**. The location signal includes positional data and time data representative of the location of the mobile device M at the time of transmission of the location signal. Preferably, the mobile device M is equipped with a global positioning system (GPS) receiver, allowing the mobile device to receive signals from the global positioning

system (represented generally as *Gin* FIG. 1) and calculate the geographic position of the mobile device *M*. As an alternative to the polling request, the mobile device *M* could be pre-programmed to transmit the location signal at a pre-set time interval without the necessity of polling. In this alternative, upon arrival at the desired location, such as, for example, arrival in the Kingdom of Saudi Arabia at the time of the Hajj, the cellular telephone or other mobile device *M* of each pilgrim will be loaded with software that automatically transmits the location information periodically to the base station **18**.

Additionally, a supplemental location signal is also transmitted to the base or tracking station **18**. The supplemental location signal includes supplemental positional data and supplemental time data representative of the location of the mobile device *M* when the mobile device is detected within proximity of a fixed sensor **14**. Preferably, the mobile device *M* has a radio frequency identification (RFID) chip **12** embedded therein, and the fixed sensor **14** is a radio frequency sensor, as shown. It should be understood that any suitable type of proximity sensor may be utilized. The RFID chip **12** is encoded with the identification data of the mobile device's user, allowing the position of the nearest radio frequency sensor **14** to be recorded as the approximate position of the person of interest. As opposed to conventional RFID systems, in which personal information such as contact numbers, addresses, medical records, etc., which use RFID tags embedded in wristbands or the like, the present system preferably utilizes RFID chip **12** embedded within the mobile device *M*, thus minimizing the possibility of loss or accidental damage to the RFID chip.

In FIG. 1, the RFID sensor **14** is shown as being in communication with the base or tracking station **18** through a hard line **16**. It should be understood that both the location signal and the supplemental location signal may be transmitted to the base or tracking station **18** via any suitable type of interface, such as a hard line, a wireless connection, a wireless mobile network, a local area network or a wide area network, such as the Internet. In the particular example of users within the city of Mecca during the Hajj, each pilgrim during the Hajj typically must have a Hajj permit, with numerous checkpoints being organized and formed throughout the city. RFID sensors **14** may be located at these already designated checkpoints, thus minimizing the need for costly and complex construction of new systems within the city.

FIG. 2 diagrammatically illustrates system components of the base or tracking station **18**. The polling signal is transmitted by a transceiver **28**, which may be any suitable type of transceiver, and the location signal and the supplemental location signal are also both received by the transceiver **28**. Additional data is entered into the system via any suitable type of user interface **24**, and may be stored in memory **22**, which may be any suitable type of computer readable and programmable memory. Calculations are performed by a processor **20**, which may be any suitable type of computer processor and may be displayed to the user on display **26**, which may be any suitable type of computer display.

The processor **20** may be associated with, or incorporated into, any suitable type of computing device, for example, a personal computer or a programmable logic controller. The display **26**, the processor **20**, the computer readable memory **22**, the transceiver **28** and any associated computer readable recording media are in communication with one another by any suitable type of data bus, as is well known in the art.

Examples of computer-readable recording media include a magnetic recording apparatus, an optical disk, a magneto-optical disk, and/or a semiconductor memory (for example,

RAM, ROM, etc.). Examples of magnetic recording apparatus that may be used in addition to memory **22**, or in place of memory **22**, include a hard disk device (HDD), a flexible disk (FD), and a magnetic tape (MT). Examples of the optical disk include a DVD (Digital Versatile Disc), a DVD-RAM, a CD-ROM (Compact Disc-Read Only Memory), and a CD-R (Recordable)/RW.

The positional data and time data, along with the supplemental positional data and the supplemental time data, are recorded in a database, or stored in memory **22** as a set of geographic positions and corresponding times associated with a path of the person of interest. A visual display image of the path of the person of interest is then displayed on display **26** at the base or tracking station **18**, the path being overlaid on a geographic map.

FIG. 3 illustrates an exemplary map display **30**, displayed to a user at the base or tracking station **18** on display **26**. The processor **20** generates the visual display image of the path of the person of interest overlaid on a geographic or topological map image **40**. The display image **30** preferably includes the date **32**, the general location **34** of the map image **40**, and the present time **42**. As shown, an icon **36** representing the person of interest at each recorded position of the person of interest on the person of interest's path is overlaid on map image **40**. A time code **38** is displayed adjacent each icon **36**, showing the position of the person of interest for each polled time.

Preferably, each icon **36** is initially displayed in a first color. If a location signal is not received at the base or tracking station following transmission of the polling request, and if an updated supplemental location signal is also not received, then the icon associated with the person of interest's last known position is displayed in a second color distinct from the first color. For example, if the person of interest goes inside a building with no cellular service, or has traveled outside of the general geographic area of interest, then the icon representing the last known position would be displayed in a different color on the display **26** at the base station **18**.

Although the system **10** in FIG. 1 is shown with only a single mobile device *M* being in communication with the base or tracking station **18**, it should be understood that this is for purposes of simplification only. The system **10** is adapted for use with large crowds, such as the Hajj pilgrimage in Mecca, which receives over 2.5 million pilgrims per year, all traveling within a relatively small city. Preferably, a large fraction of the pilgrims would be provided with mobile devices *M*, each being adapted for receiving the polling signal and transmitting the location and supplemental location signals. Similarly, although only a single RFID sensor **14** is shown, it should be understood that such sensors would preferably be arranged in a grid throughout the city. As described above, each mobile device has an identifier associated therewith, allowing the base or tracking station to send a polling signal directed at only one mobile device *M*, and also allowing each RFID sensor **14** to distinguish the person who is traveling in proximity thereto. During the Hajj, each group of pilgrims (typically numbering a few thousand) typically has a guide, referred to as a "Mutawif" in Arabic. In addition to tracking the pilgrims at base station **18**, the location information received and calculated at the base station **18** could be retransmitted to the guide, allowing the guide to have a visual representation of the locations of each member of his group, thus ensuring that pilgrims do not get lost as they navigate through the city.

It should be understood that the mobile device *M* may include additional functions, such as a call for emergency aid that would include the user's position, or any other suitable



5

type of geographic-dependent function typically associated with GPS-enabled mobile devices.

As a further alternative, the RFID chip and associated sensor **14** may be replaced with a conventional near field communication (NFC) system. NFC is presently becoming a standard in cellular telephones, and thus may be easily applied to the above services, as well as providing additional services to the users. NFC is a set of short-range wireless technologies, typically requiring a distance of four cm or less. NFC operates at 13.56 MHz and at rates ranging from 106 kbit/s to 848 kbit/s. NFC always involves an initiator and a target. The initiator actively generates a radio frequency (RF) field that can power a passive target. This enables NFC targets to take very simple form factors, such as tags, stickers, key fobs, or cards that do not require batteries. NFC peer-to-peer communication is also possible, where both devices are powered. In the system **100** of FIG. **4**, the RFID chip has been replaced by an NFC initiator **112**, and the RFID sensor has been replaced by an NFC target **114**, which communicates with the base station **18** via line **116**.

As noted above, pilgrims must have a Hajj permit during their pilgrimage to Mecca. The NFC initiator **112** has on-board memory associated therewith, containing all relevant identification and travel information, such as the user's photographic image (stored as a digital image), identification documents, an electronic pilgrimage permit, financial transaction information (as is conventionally known in the field of c-commerce), health and medical information, contact information, phone numbers and addresses of user-specific and Hajj-specific travel sites, etc. In this way, the mobile device M may replace the conventional paper Hajj permit with a simple and easy electronic version, allowing for quick and efficient travel by replacing time-consuming permit checkpoints with NFC targets **114**.

Rather than having a paper permit manually checked at a checkpoint, a user simply will present a mobile device M equipped with an NFC initiator **112** to an NFC target **114**, authorizing pilgrim travel and facilitating their movements, while still allowing for the security of prohibiting unauthorized people from free movement within the city. Due to the enhanced functionality of NFC, the mobile device M can also be used for electronic purchases, as is known in the art of e-commerce, thus reducing the possibility of loss or theft of conventional paper currency.

Further, identification and medical information may be easily stored in the memory of the mobile device M having the NFC, allowing for efficient treatment of the user in the case of a medical emergency. Further, given the identification and location data also stored in the memory, authorities can easily aid lost pilgrims in finding their way, even when the pilgrims do not speak the local language. It should be understood that mobile devices that are not yet equipped with NFC may use an RFID system, such as that described above with reference to FIG. **1**.

Further, as described above, the base station **18** regularly polls the mobile device M to receive location information (or the mobile device M transmits such information on a predetermined schedule). In the event that cellular service is interrupted or not available, and/or the Internet or other connection between an RFID sensor **14** or an NFC target **114** and the base station **18** is interrupted, the mobile device M regularly checks its ability to properly transmit data, and if it is found that data is not being properly transmitted, the location and associated time data is stored in the mobile device's on-board memory for later transmission. When a transmission path to the base station **18** is restored, the location and time information stored in memory is transmitted to the base station **18** and

6

the on-board memory is cleared. In order to save memory space, a time threshold may be pre-set so that newer location information can replace older stored information.

It is to be understood that the present invention is not limited to the embodiments described above, but encompasses any and all embodiments within the scope of the following claims.

I claim:

1. A method of tracking people, comprising the steps of:
  - transmitting a polling request to a mobile device associated with a particular person of interest;
  - in response to the polling request, transmitting a location signal including positional data and time data representative of the location of the mobile device at the time of reception of the polling request;
  - determining if the location signal transmitted by the mobile device is being received and if communication is interrupted, then storing the positional data and the time data in on-board memory until communication is re-established and at that time, re-transmitting the location signal and clearing the stored positional data and the time data from the on-board memory, wherein the stored positional data and time data is stored for a pre-set time threshold after which subsequent positional data and time data overwrites the original stored positional data and time data;
  - receiving a supplemental location signal from a fixed sensor, the supplemental signal including supplemental positional data and supplemental time data representative of the location of the mobile device when the mobile device is detected within proximity of a fixed sensor;
  - recording the positional and time data and the supplemental positional and supplemental time data in a database as a set of geographic positions and corresponding times associated with a path of the person of interest;
  - generating a visual display image of the path of the person of interest overlaid on a geographic map; and
  - transmitting the positional and time data and the supplemental positional and supplemental time data to a single guide of a group of people, the group of people including the person of interest.
2. The method of tracking people as recited in claim 1, wherein the step of transmitting the polling request includes transmitting identification data associated with the mobile device of the person of interest.
3. The method of tracking people as recited in claim 2, wherein the step of generating the visual display image includes displaying an icon representing the person of interest at each recorded position of the person of interest on the path of the person of interest.
4. The method of tracking people as recited in claim 3, wherein the step of generating the visual display image further includes displaying the time data associated with each recorded position, the time data being displayed adjacent the respective icon associated therewith.
5. The method of tracking people as recited in claim 4, wherein the step of generating the visual display image includes displaying each said icon in a first color, wherein if a location signal is not received following transmission of the polling request and an updated supplemental location signal is not received, then displaying the icon associated with the person of interest's last known position in a second color distinct from the first color.
6. The method of tracking people as recited in claim 5, further comprising the steps of:
  - receiving GPS positional data of the mobile device from the global positioning system; and

7

generating the positional data based upon the GPS positional data.

7. The method of tracking people as recited in claim 6, wherein the fixed sensor comprises an RFID receiver, the supplemental positional data and supplemental time data being generated upon detection of an RFID chip embedded in the mobile device in proximity of a fixed radio frequency sensor.

8. The method of tracking people as recited in claim 6, wherein the fixed sensor comprises a near field communication target, the supplemental positional data and supplemental time data being generated upon detection of a near field communication initiator embedded in the mobile device in proximity of the near field communication target.

9. A method of tracking people, comprising the steps of: transmitting a polling request to a mobile device associated with a particular person of interest;

in response to the polling request, transmitting a location signal including positional data and time data representative of the location of the mobile device at the time of reception of the polling request;

transmitting a supplemental location signal through a fixed sensor, the supplemental signal including supplemental positional data and supplemental time data representative of the location of the mobile device when the mobile device is detected within proximity of the fixed sensor; determining if the location signal transmitted by the mobile device is being received and if communication is interrupted, then storing the positional data and the time data in on-board memory until communication is re-established and at that time, re-transmitting the location signal and clearing the stored positional data and the time data from the on-board memory, wherein the stored positional data and time data is stored for a pre-set time threshold after which subsequent positional data and time data overwrites the original stored positional data and time data;

recording the positional and time data and the supplemental positional and supplemental time data in a database as a set of geographic positions and corresponding times associated with a path of the person of interest;

generating a visual display image of the path of the person of interest overlaid on a geographic map; and

transmitting the positional and time data and the supplemental positional and supplemental time data to a single guide of a group of people, the group of people including the person of interest.

10. The method of tracking people as recited in claim 9, wherein the step of transmitting the polling request includes transmitting identification data associated with the mobile device of the person of interest.

11. The method of tracking people as recited in claim 10, wherein the step of generating the visual display image includes displaying an icon representing the person of interest at each recorded position of the person of interest on the path of the person of interest.

12. The method of tracking people as recited in claim 11, wherein the step of generating the visual display image further includes displaying the time data associated with each recorded position, the time data being displayed adjacent the respective icon associated therewith.

13. The method of tracking people as recited in claim 12, wherein the step of generating the visual display image includes displaying each said icon in a first color, wherein if a location signal is not received following transmission of the polling request and an updated supplemental location signal

8

is not received, then displaying the icon associated with the person of interest's last known position in a second color distinct from the first color.

14. The method of tracking people as recited in claim 13, further comprising the steps of:

receiving GPS positional data of the mobile device from the global positioning system; and  
generating the positional data based upon the GPS positional data.

15. The method of tracking people as recited in claim 14, wherein the fixed sensor comprises an RFID receiver, the supplemental positional data and supplemental time data being generated upon detection of an RFID chip embedded in the mobile device in proximity of a fixed radio frequency sensor.

16. The method of tracking people as recited in claim 14, wherein the fixed sensor comprises a near field communication target, the supplemental positional data and supplemental time data being generated upon detection of a near field communication initiator embedded in the mobile device in proximity of the near field communication target.

17. A system for tracking people, comprising:

means for transmitting a polling request to a mobile device associated with a particular person of interest;

means for transmitting a location signal including positional data and time data representative of the location of the mobile device at the time of transmission of the location signal upon receipt of the polling request;

a near field communication initiator for transmitting a supplemental location signal including supplemental positional data and supplemental time data representative of the location of the mobile device when the mobile device is detected within proximity of a fixed near field communication target;

means for recording the positional and time data and the supplemental positional and supplemental time data in computer readable memory as a database including a set of geographic positions and corresponding times associated with a path of the person of interest;

means for determining if the location signal transmitted by the mobile device is being received and if communication is interrupted, then storing the positional data and the time data in on-board memory until communication is re-established and at that time, re-transmitting the location signal and clearing the stored positional data and the time data from the on-board memory, wherein the stored positional data and time data is stored for a pre-set time threshold after which subsequent positional data and time data overwrites the original stored positional data and time data;

means for generating a visual display image of the path of the person of interest overlaid on a geographic map; and  
transmitting the positional and time data and the supplemental positional and supplemental time data to a single guide of a group of people, the group of people including the person of interest.

18. The system for tracking people as recited in claim 17, wherein said means for transmitting the polling request comprises a transceiver associated with a remote tracking station.

19. The system for tracking people as recited in claim 18, further comprising a GPS receiver integrated into the mobile device.

20. The system for tracking people as recited in claim 15, further comprising:

an RFID chip embedded in the mobile device, wherein the supplemental location signal is transmitted when the

RFID chip associated with the mobile device is detected within proximity of a fixed radio frequency sensor;  
means for transmitting identification data associated with the mobile device of the person of interest;  
means for displaying an icon representing the person of interest at each recorded position of the person of interest on the path of the person of interest;  
means for displaying the time data associated with each recorded position, the time data being displayed adjacent the respective icon associated therewith; and  
means for displaying each said icon in a selected color, wherein each said icon is initially displayed in a first color and if a location signal is not received following transmission of the polling request and an updated supplemental location signal is not received, then the icon associated with the person of interest's last known position is displayed in a second color distinct from the first color.

\* \* \* \* \*